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Wind Power Price Trends in the United States

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For the fourth year in a row, the United States led the world in adding new wind power capacity in 2008, and also surpassed Germany to take the lead in terms of cumulative installed wind capacity. The rapid growth of wind power in the U.S. over the past decade (Figure 1) has been driven by a combination of increasingly supportive policies (including the Federal production tax credit (PTC) and a growing number of state renewables portfolio standards), uncertainty over the future fuel costs and environmental liabilities of natural gas and coal-fired power plants, and wind's competitive position among generation resources. This article focuses on just the last of these drivers – i.e., trends in U.S. wind power prices – over the period of strong capacity growth since 1998.

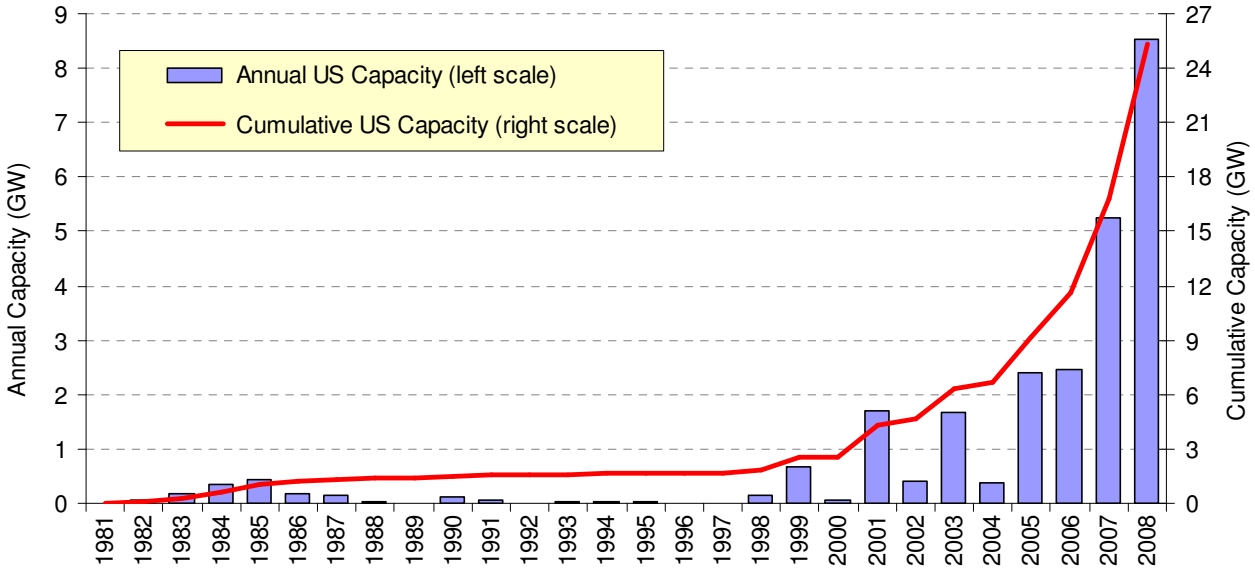

Figure 1. Annual and Cumulative Growth in U.S. Wind Power Capacity

Wind Power Price Trends in the U.S.

Berkeley Lab maintains a database of wind power sales prices, which currently contains price data for 145 wind projects installed in the U.S. between 1998 and the end of 2008. These projects total 9,873 MW, or 42% of the wind capacity brought on line in the U.S. over the 1998-2008 period. The dataset excludes utility-owned projects, as well as merchant plants and other projects that sell renewable energy certificates (RECs) separately from the underlying power.[2]

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[2] Utility-owned projects are excluded because there is no observable wholesale price associated with utility-owned wind power; rather, the power is most often delivered to the utility's retail customers as part of the utility's power

As such, the prices in this database reflect the bundled price of electricity and RECs as sold by the project owner under a power purchase agreement. Because these prices are artificially suppressed by the receipt of available state and federal incentives, they do not represent the true *cost* of wind generation (which would be at least $20/MWh higher than the prices shown here, due to the impact of the Federal PTC on wind power prices).

Based on this database, the capacity-weighted average power sales price from this sample of post-1997 wind projects remains low by historical standards. Figure 2 shows the cumulative capacity-weighted average wind power price (along with the range of individual project prices falling between the 25th and 75th percentiles) in each calendar year from 1999 through 2008. Based on the limited sample of 7 projects built in 1998 or 1999 and totaling 450 MW, the weighted-average price of wind in 1999 was more than $64/MWh (expressed in 2008 dollars). By 2008, in contrast, the cumulative sample of projects built from 1998 through 2008 had grown to 145 projects totaling 9,873 MW, with an average price of just over $40/MWh (with 50% of individual project prices falling between $33/MWh and $51.5/MWh). Although Figure 2 does show a modest increase in the weighted-average wind power price over the past three years, reflecting rising prices from new projects, the cumulative nature of the graphic mutes the degree of increase.

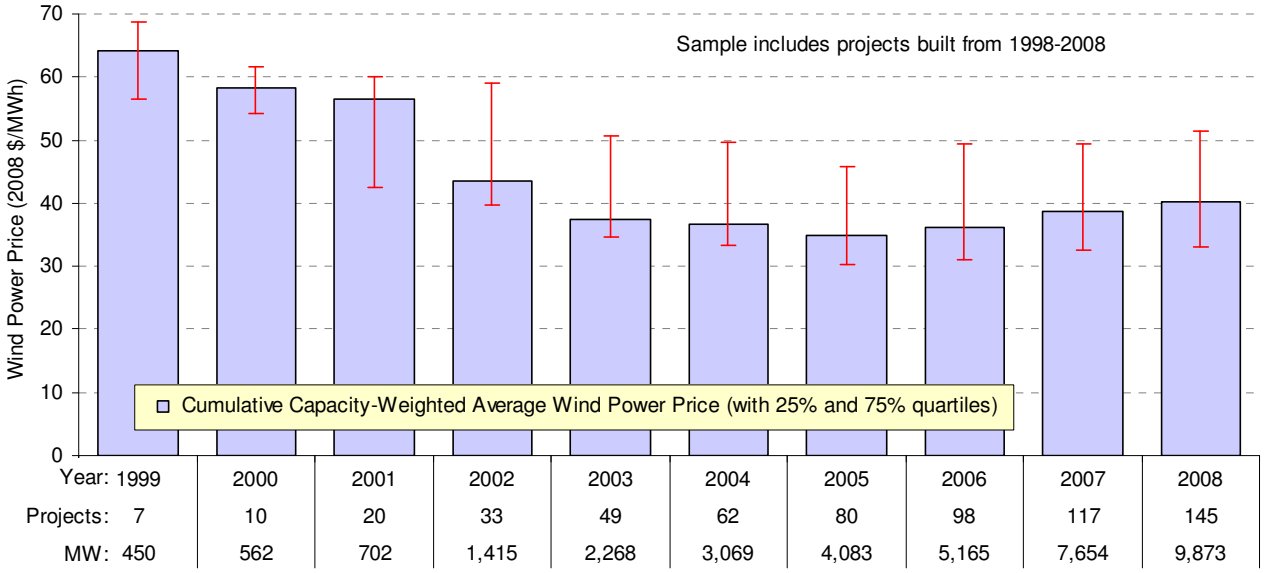

Figure 2. Cumulative Capacity-Weighted Average Wind Power Prices Over Time

To better illustrate changes in the price of power from newly built wind projects, Figure 3 shows average wind power sales prices in 2008, grouped by project vintage (i.e., by each project's initial commercial operation date).[3] Although the limited project sample and the considerable variability in prices across projects installed in a given time period complicate analysis of

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supply mix. Merchant plants and other projects that sell RECs separately from the underlying power are excluded because the wind power sales price represents only a portion of the total market revenue received by such projects.

[3] Prior to 2006, Figures 3 and 6 combine data into two-year periods in order to avoid distortions related to small sample size in the PTC lapse years of 2000, 2002, and 2004. Though not a PTC lapse year, 1998 is grouped with 1999 due to the small sample of 1998 projects.

national price trends (with averages subject to regional and other factors), the general trend exhibited by the capacity-weighted-average prices nevertheless suggests that, following a general decline since 1998, prices bottomed out for projects built in 2002 and 2003, and have since risen significantly.[4] Specifically, the capacity-weighted average 2008 sales price for projects in the sample built in 2008 was roughly $51.5/MWh, up from an average of $43.2/MWh for the sample of projects built in 2007, and $20.6/MWh higher than the average of $30.9/MWh among projects built at the low point in 2002 and 2003.

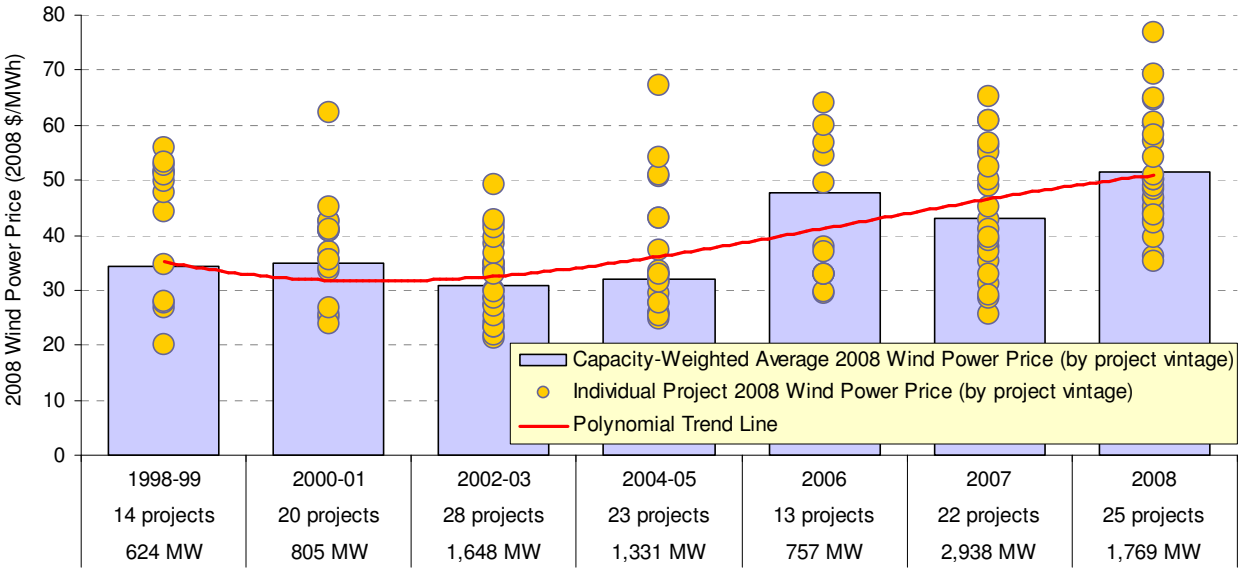

Figure 3. 2008 Wind Power Prices by Project Vintage

The wind power sales prices shown in Figures 2 and 3 reflect the total amount of revenue (above and beyond any government incentives) required to generate a target return for project investors, given the installed cost of the project and the amount of electricity that project is expected to generate over time.[5] To facilitate an understanding of the price trends shown in Figures 2 and 3, and where wind power prices might be headed in the near-term, the rest of this article examines each of these three primary drivers, in turn: installed project costs, capacity factors, and financing terms.

[4] Although it may seem counterintuitive, the weighted-average price in 1999 for projects built in 1998 and 1999 (shown in Figure 2 to be about $64/MWh) is significantly higher than the weighted-average price in 2008 for projects built in 1998 and 1999 (shown in Figure 3 to be about $34/MWh) for three reasons: (1) the sample size is larger in Figure 3, due to the fact that 2008 prices are presented, rather than 1999 prices as in Figure 2 (i.e., we were unable to obtain early-year pricing for some of the projects built in 1998-1999); (2) two of the larger projects built in 1998 and 1999 (for which both 1999 and 2008 prices are available, meaning that these projects are represented within both figures) have nominal PPA prices that actually *decline*, rather than remaining flat or escalating, over time; and (3) inflating all prices to constant 2008 dollar terms impacts older (i.e., 1999) prices more than it does more-recent (i.e., 2008) prices.

[5] The price that the market will bear – i.e., the level of wholesale power prices in the region where the project is located – may also exert an influence on wind power prices in some cases.

Installed Project Costs

Installed project costs are primarily a function of wind turbine prices, which account for 70-80% of total installed costs. Berkeley Lab has gathered data on 58 U.S. wind turbine transactions since 1998 totaling more than 21,100 MW, including 10 transactions summing to 4,500 MW in 2008 alone. Figure 4 depicts the reported prices from these transactions. As suggested by the trend line, turbine prices increased by roughly $700/kW on average from the bottom in 2001 through the peak in 2008. More recently, however, falling commodity prices, a stronger U.S. dollar, and slackening demand due to the global recession have begun to place downward pressure on turbine prices. The beginnings of such a reversal can be seen in Figure 4, though sample size since mid-2008 has been extremely limited, as the finance-induced slowdown in development activity has left most U.S. wind project developers with little need to place additional turbine orders (i.e., most developers already have enough turbines on hand to meet their near-term needs).

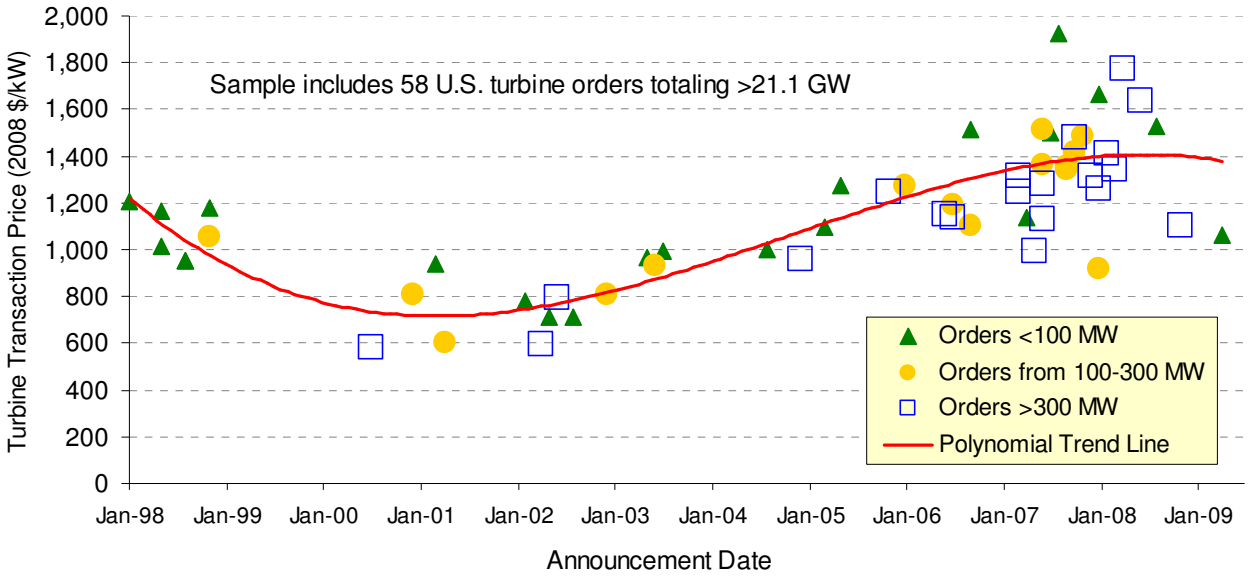

Figure 4. Reported U.S. Wind Turbine Transaction Prices Over Time

Given the upward trend in turbine prices for most of this decade, it should come as no surprise that installed project costs have also been increasing, and by roughly the same amount (~$700/kW through 2008). What might be surprising, given the apparent recent softening in turbine prices noted above, are expectations for installed costs to increase even further among 6 GW of wind projects expected to be built in 2009 and 2010 (Figure 5). Once again, though, this continued upward trend reflects the predicament of U.S. wind project developers, many of whom locked in high turbine prices through long-term frame agreements signed at the peak of the market in late 2007 and early 2008. Before the reported softening in spot turbine prices can begin to flow through the development pipeline to any significant degree, these developers first need to work through their backlog of higher-priced turbines.

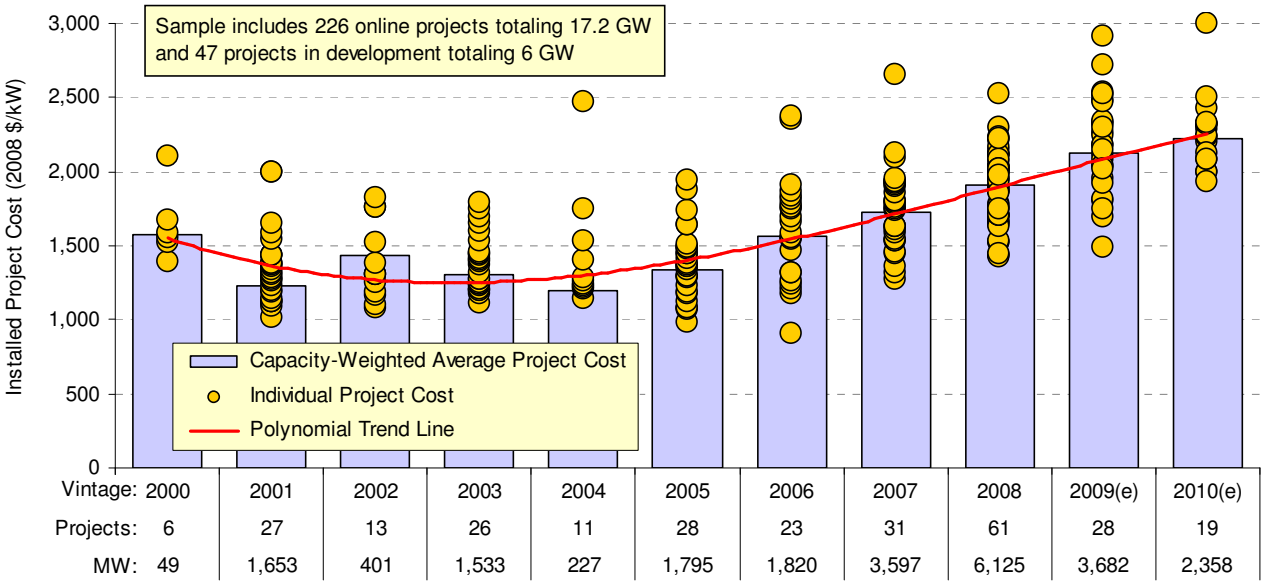

Figure 5. Installed Wind Project Costs Over Time

Capacity Factor

Offsetting the rise in installed project costs, at least to some degree, has been a notable increase in capacity factor among more recently built projects. Figure 6 shows capacity factors in calendar year 2008 for a sample of 183 wind projects totaling more than 14.1 GW (accounting for 84% of nationwide installed wind capacity at the end of 2007) and broken out by project vintage. Although the range of 2008 capacity factors among individual projects built within any given period is quite large, the capacity-weighted average capacity factors improved steadily and significantly through the 2004-2005 project vintage, before leveling off among projects built in 2006 and 2007.[6] All else equal, projects with higher capacity factors require less revenue per unit output.

[6] Potential reasons why 2008 capacity factors seem to have leveled off (on average) for 2006 and 2007 vintage projects include the following: (1) for projects completed in late 2007, the initial break-in period during which operational kinks are worked out may have extended into 2008; (2) curtailment of wind project output due to transmission inadequacy and low wholesale market prices is reportedly a growing problem, primarily in Texas, but also in other markets; (3) wind project developers may be reacting to increasing transmission constraints, or even just regionally differentiated wholesale power prices, by focusing on those projects in their development pipeline that may not have the highest capacity factor, but that do have ready access to unconstrained transmission or high-priced markets; and (4) some wind turbine manufacturers experienced blade and gearbox problems among their fleet of turbines installed in 2007 (and 2008).

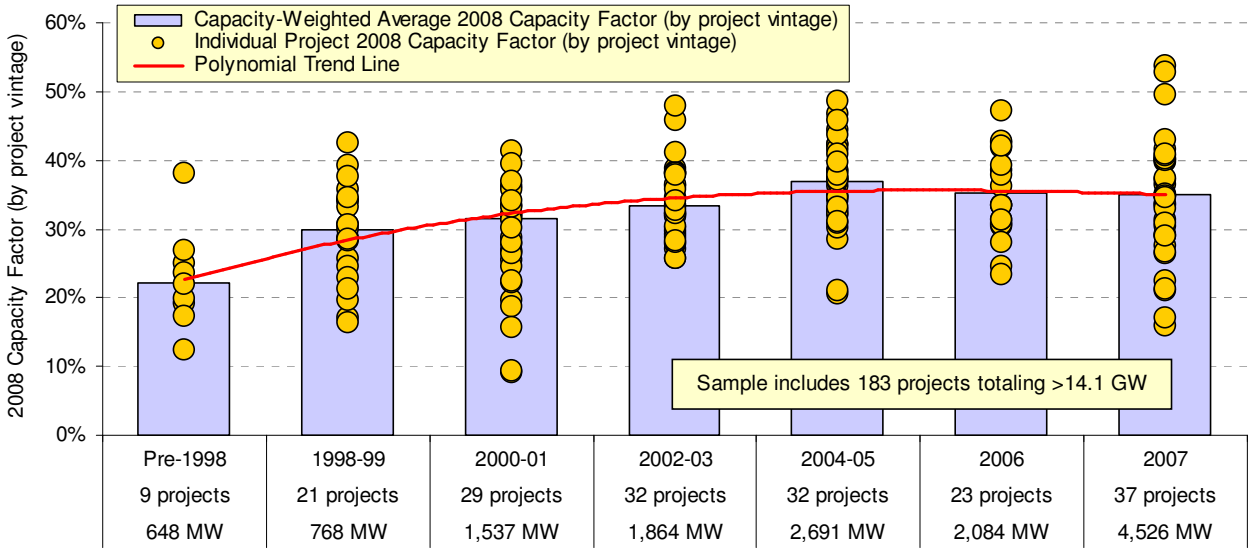

Figure 6. 2008 Project Capacity Factors by Project Vintage

Financing Terms

Because wind projects are so capital-intensive (i.e., most of the cost of a wind project is incurred before the project even begins generating power), financing terms can have a significant impact on wind power prices. As was the case with higher capacity factors, improvements in wind project financing terms earlier in the decade also helped to mitigate the impact of rising installed project costs on wind power prices. Specifically, the cost of tax equity provided to high-quality projects reportedly dropped by roughly 300 basis points (3%) through 2007, while spreads on debt instruments narrowed at the same time as the scope and tenor of debt offerings increased.

Since mid-2008, however, the global financial crisis has eroded many of those earlier gains. The number of tax equity investors still seeking investments in wind projects has declined precipitously, and those few that remain in the market are charging significantly more – on the order of 200-300 basis points more – for their capital. Similarly, banks have retrenched on debt financing.

As a result, whereas project finance helped to alleviate upward wind power price pressures earlier in the decade, it is now contributing to such pressures.

Conclusions

It is possible to evaluate the relative impact of each of the three primary drivers discussed above on wind power prices by running the empirically observed changes in each driver through a standard pro forma financial model, while holding all other variables constant. Doing so yields the following results: (1) the $700/kW increase in installed project costs adds almost $35/MWh to wind power prices, all else equal; (2) a 3% improvement in capacity factor reduces wind power prices by about $7/MWh, all else equal; and (3) a 300 basis point reduction in tax equity

returns (prior to the financial crisis) reduces wind power prices by about $13/MWh, all else equal. On net, these three drivers sum to an increase of more than $15/MWh in wind power prices since earlier in the decade – an amount that is roughly consistent with the empirically observed prices shown earlier in Figure 3.

Looking ahead, the outlook is mixed. If sustained, the mid-2008 reversal in commodity costs and exchange rates should continue to soften U.S. turbine prices. Softer turbine prices may, however, take some time to show up in average installed project costs, as developers continue to work through a backlog of surplus turbines ordered at peak prices. In the near term, therefore, average installed project costs will likely remain relatively high, and perhaps go even higher (as suggested earlier in Figure 5). These sustained high project costs, coupled with less-favorable financing terms (i.e., higher required tax equity returns), will likely push the price of power from new U.S. wind projects higher in 2009. Over the longer term, however, softer turbine prices and a return to normally functioning credit markets should eventually help wind power regain the downward price path that it has generally followed – with the exception of much of this decade – since the 1980s.